

# NOTES 10: SAMPLING DISTRIBUTIONS

Stat 120 | Fall 2025

Prof Amanda Luby

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“Big picture” picture:

Quantity	Statistic	Parameter
Mean		
Proportion		
Standard Deviation		
Correlation		
Regression Coefficient		

Carleton publishes an “at a glance” page with some facts and figures about the student body:  
<https://www.carleton.edu/about/carleton-at-a-glance/>

Some highlights:

- Geographic distribution:
  - Midwest 36.7%
  - West 21.7%
  - East 17.3%
  - South 10.9%
  - International 11.8%
  - Other 1.6%
- 34% BIPOC
- 12% are among the first generation in their families to attend college
- 61% graduated in the top 10% of their high school class

In a moment, we’re going to see one of these quantities for our class. Before we do, what is your *best* guess for each of these quantities?

**Example:** In this set-up, what is the:

- Population
- Sample
- Parameter

- Statistic

We know that our class will likely not have **exactly** 36.7% from the Midwest, but we probably wouldn't expect it to be 0% or 90%.

### Sampling variability

We might start to ask ourselves, what if a *different* set of 32 students enrolled in this course?

First, we create a population.

```
# A tibble: 2,007 x 2
  student_id midwest
      <int> <chr>
1        72 Yes
2      1327 No
3      1100 No
4       244 Yes
5       308 Yes
6       152 Yes
7       676 Yes
8      1397 No
9       518 Yes
10     1247 No
# i 1,997 more rows
```

Then, we take a random sample:

```
set.seed(100424)
sample1 <- carls |>
  sample_n(32)
sample1
```

```
# A tibble: 32 x 2
  student_id midwest
      <int> <chr>
1        1826 No
2        1997 No
3         279 Yes
4        1505 No
5         770 No
6       1111 No
7       1309 No
8       1912 No
```

```
9      1302 No
10     1959 No
# i 22 more rows
```

and calculate the proportion of “yes” responses:

```
sample1 |>
  group_by(midwest) |>
  summarize(
    n = n()
  ) |>
  mutate(p_hat = n/sum(n))
```

```
# A tibble: 2 x 3
  midwest     n p_hat
  <chr>    <int>  <dbl>
1 No        21  0.656
2 Yes       11  0.344
```

This isn’t *super* useful, but if we do it a bunch of times, we can start to see what a range of possible samples could look like. (Note: this code requires the {infer} package)

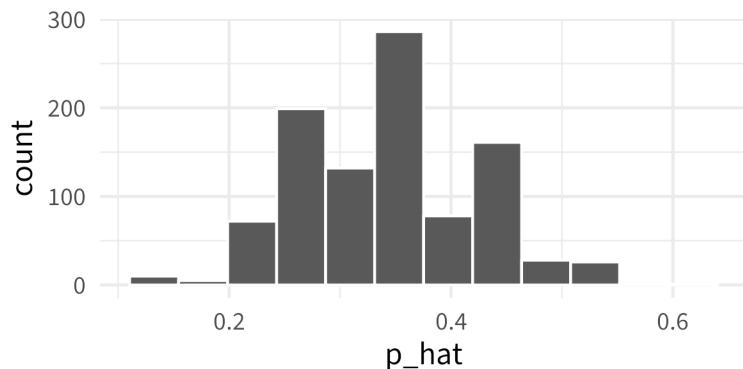
```
many_samples <- carls |>
  rep_sample_n(35, reps = 1000, replace = TRUE) |>
  group_by(replicate, midwest) |>
  summarize(
    n = n()
  ) |>
  mutate(p_hat = n/sum(n)) |>
  filter(midwest == "Yes")

many_samples
```

```
# A tibble: 1,000 x 4
# Groups:   replicate [1,000]
  replicate midwest     n p_hat
  <int>    <chr>    <int>  <dbl>
1       1 Yes      9  0.257
2       2 Yes      7  0.2
3       3 Yes     11  0.314
4       4 Yes     15  0.429
5       5 Yes     18  0.514
6       6 Yes      7  0.2
7       7 Yes     18  0.514
8       8 Yes     14  0.4
9       9 Yes     17  0.486
```

```
10      10 Yes      15 0.429
# i 990 more rows
```

Looking at this first few rows, we can start to get a sense of the range of possible sample proportions, but there are 990 rows that we can't see. Let's make a graph!



**Example:** Carleton Mission Statement

*In your own words:* provide explanations for:

Population distribution

Sample distribution

Sampling distribution